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$$\therefore y^2 - 9 = y \frac{B}{A} - 3 \frac{B}{A}, \therefore y^2 - \frac{B}{A}y = 9 - 3 \frac{B}{A}.$$

Completing the square root, $y^2 - \frac{B}{A}y + \frac{B^2}{4A^2} = 9 - 3 \frac{B}{A} + \frac{B^2}{4A^2}$, $\therefore y = 3$.

Substituting value of y in (4) and (5),

$$x - 4 = c(2 - z) \dots (9), d(x - 4) = 2 - z \dots (10).$$

Eliminating $(2 - z)$ between (9) and (10), $\frac{x - 4}{c} = d(x - 4) = x^2 - 16$,

$$\therefore x^2 - \frac{x}{c} = 16 - \frac{4}{c}. \quad \therefore x^2 - \frac{x}{c} + \frac{1}{4c^2} = 16 - \frac{4}{c} + \frac{1}{4c^2}, \therefore x = 4.$$

Values of x and y in $x^2 + y^2 + z = 45$, gives $z = 2$.

$$\therefore x = 4, y = 3, z = 2.$$

Also solved by *Professor W. F. Bradbury*.

10. Proposed by J. K. ELLWOOD, A. M., Principal of Colfax School, Pittsburg, Pennsylvania.

$$x^2 + y^2 + w^2 + z^2 = 65 \dots (1),$$

$$(x + z)^2 + (y + w)^2 = 113 \dots (2),$$

$$(y + z)^2 + (x + w)^2 = 117 \dots (3),$$

$$(x + y)^2 + (z + w)^2 = 125 \dots (4).$$

How many values has each of the four unknown quantities?

Solution by W. F. BRADBURY, A. M., Head-Master Cambridge Latin School, Cambridge, Massachusetts.

From (1) subtract (2), (3), and (4), successively,

$$2xz + 2yw = 48 \dots (5),$$

$$2yz + 2xw = 52 \dots (6),$$

$$2xy + 2zw = 60 \dots (7).$$

Adding (5), (6), and (7), we get,

$$(x + y + z + w)^2 = 225 \dots (8), \quad x + y + z + w = \pm 15 \dots (9).$$

Using only + values, $x + z = 15 - (y + w) \dots (10)$.

Substituting in (2), $225 - 30(y + w) + (y + w)^2 + (y + w)^2 = 113 \dots (11)$,
 $(y + w)^2 - 15(y + w) = -56 \dots (12)$,

$$y + w = \frac{15}{2} \pm \sqrt{\frac{225}{4} - \frac{224}{4}} = \frac{15}{2} \pm \frac{1}{2} = 8, \text{ or } 7 \dots (13).$$

Hence from (10), $x + z = 7$, or 8. In like manner, substituting from (9) in (3) and (4), we find $y + z = 6$, or 9; $x + w = 9$, or 6; $x + y = 5$; $z + w = 10$.

From these we find, $x = 3$, or 2, $y = 2$, or 3, $w = 6$, or 4, $z = 4$, or 6. Using the negative values other answers can be found.

[There are in all 16 values for each of the unknown quantities, arising from the reduced equations $x + y + z + w = \pm 15$, $x + y + z + w = \pm 5$, $x + y + z - w = \pm 1$, $x - y - z + w = \pm 3$, as follows:

$$x = \pm 6, \pm 4, \pm 2, \pm 3, \pm 4\frac{1}{2}, \pm 5\frac{1}{2}, \pm 3\frac{1}{2}, \pm 1\frac{1}{2}.$$

$$y = \pm 4; \pm 6, \pm 3, \pm 2, \pm 5\frac{1}{2}, \pm 4\frac{1}{2}, \pm 1\frac{1}{2}, \pm 3\frac{1}{2}.$$

$$z = \pm 2, \pm 3, \pm 6, \pm 4, \pm 3\frac{1}{2}, \pm 1\frac{1}{2}, \pm 4\frac{1}{2}, \pm 5\frac{1}{2}.$$

$$w = \pm 3, \pm 2, \pm 4, \pm 6, \pm 1\frac{1}{2}, \pm 3\frac{1}{2}, \pm 5\frac{1}{2}, \pm 4\frac{1}{2}. \text{—EDITOR.}]$$

Also solved by *Professor G. B. M. ZERR*.